Chemical Reuse, Recovery and Recycling in Textile Factories

Promotion of Sustainability in the Textile and Garment Industry in Asia-FABRIC

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

4. Best available Techniques

13.45– 14:30

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Agenda

- **Recovery of PVA**
- **Recovery of Caustic**
- **Recovery of Printing paste**

BAT - BREF

A BREF – a Best Available Technique (BAT) Reference Document – is a publication resulting from a series of exchanges of information between a variety of stakeholders, including regulators, industry and environmental non-governmental organisations.

BREFs bring together users' real-world experiences of BAT to provide reference information for regulators to use when determining permit conditions.
The documents describe, in particular, applied techniques, present emissions and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques.

BAT conclusions are the final evaluations of Best Available Techniques and form part of every BREF. They determine the reference points used to set permit conditions for installations covered by the IED (Industrial Emissions Directive)..

BAT

The BREFs are a series of reference documents covering, as far as is practicable, the industrial activities listed in Annex 1 to the EU's IPPC Directive. They provide descriptions of a range of industrial processes and for example, their respective operating conditions and emission rates. Member States are required to take these documents into account when determining best available techniques generally or in specific cases under the Directive.

The link address is: http://eippcb.jrc.ec.europa.eu/reference/

This presentation addresses a selection of textile finishing processes and their options for chemicals recovery on the basis of the BAT / BREF document.

Recovery of PVA

Neither enzymatic nor oxidative desizing allows size recovery, while for some synthetic sizing agents size recovery is technically feasible, but difficult to apply for commission companies working on commission.

Description

When desizing is carried out by washing with hot water, water-soluble sizing chemicals (e.g. polyvinyl alcohol and polyacrylates) are recovered from the washing water by ultrafiltration. The concentrate is reused for sizing, whereas the permeate is reused for washing.

Technical description

Sizing agents are applied to warp yarn in order to protect it during the weaving process and have to be removed during textile pretreatment, thus giving rise to 40-70 % of the total COD load of woven fabric finishing mills.

Water-soluble synthetic sizing agents such as polyvinyl alcohol, polyacrylates and carboxymethyl cellulose can be recovered from washing liquor by ultrafiltration. More recently, it has been confirmed that modified starches such as carboxymethyl starch can also be recycled.

Recovery of PVA

The sizing agent's concentration in the washing liquor is about 20-30 g/l. In the ultrafiltration plant, they are concentrated to 150-350 g/l. The concentrate is recovered and can be reused for sizing, whereas the permeate can be recycled as water in the washing machine. Note that the concentrate is kept at a high temperature (80-85 °C) and does not need to be reheated, which results in less energy consumption.

Achieved environmental benefits

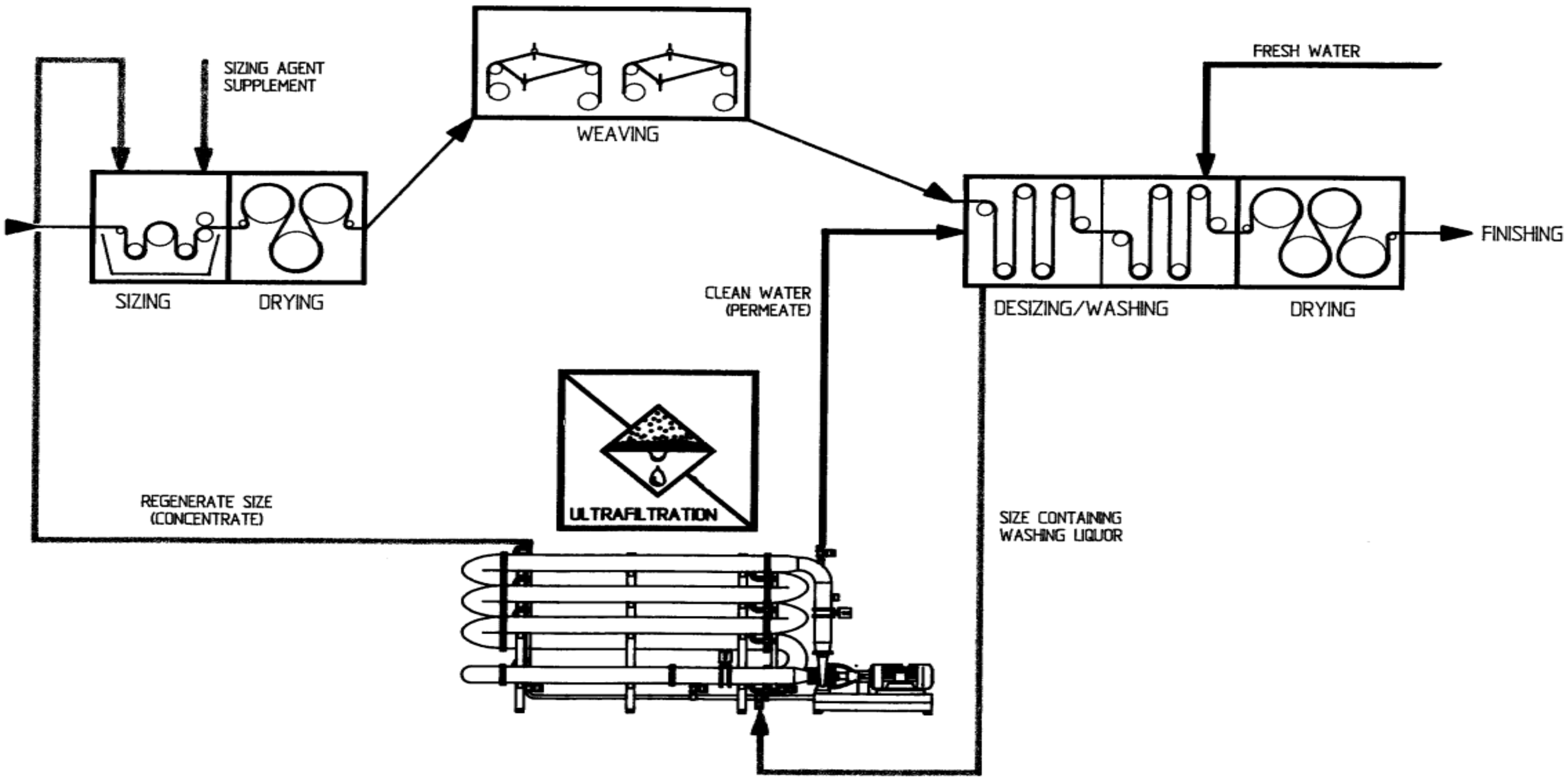
- Resource efficiency as sizing agents are recovered.
- Reduction of the pollutant loads in the wastewater.
- Reduction of energy consumption.

In addition, sizing agents in wastewater do not need to be treated. Thus, energy consumption for treatment is reduced significantly as well as quantity of sludge to be disposed of [UBA, 2001].

Environmental performance and operational data

It can be noticed that, even with recovery, some losses of sizing agent still occur at various stages of the process, especially during weaving. Furthermore, a certain amount of sizing agent still remains on the desized fabric and a fraction ends up in the permeate. The percentage of sizing agents which can be recovered is 80-85 %.

Recovery of sizing agents by ultrafiltration



Source: [179, UBA, 2001]

Caustic Recovery Plant

Mercerising is responsible for a large amount of strong alkali that is discharged in wastewater and needs to be neutralised. The corresponding salt is formed after neutralisation. In this respect, the cold process involves higher emission loads than the hot one. In order to allow the required retention time and make possible the cooling of the bath in continuous mode possible, a portion of the bath needs to be taken out removed and cooled down in continuous mode. This means that higher volumes of bath are necessary in cold mercerising, which also result in higher emissions if the caustic soda is not recovered. Mercerising baths are usually recovered and reused. When this is not possible, they are used as alkali in other preparation treatments

Description

Caustic soda is recovered from the rinsing water by evaporation and further purified, if needed.

Technical description

During the mercerisation process, cotton yarn or fabric (mainly woven fabric but also knitted fabric) is treated under tension in a solution of concentrated caustic soda (270-300 g NaOH/l, or also 170-350 g NaOH/kg textile substrate) for about 40-50 seconds. The textile substrate is then rinsed in order to remove caustic soda. This rinsing water is called weak lye (40-50 g NaOH/l) and can be concentrated by evaporation for recycling.

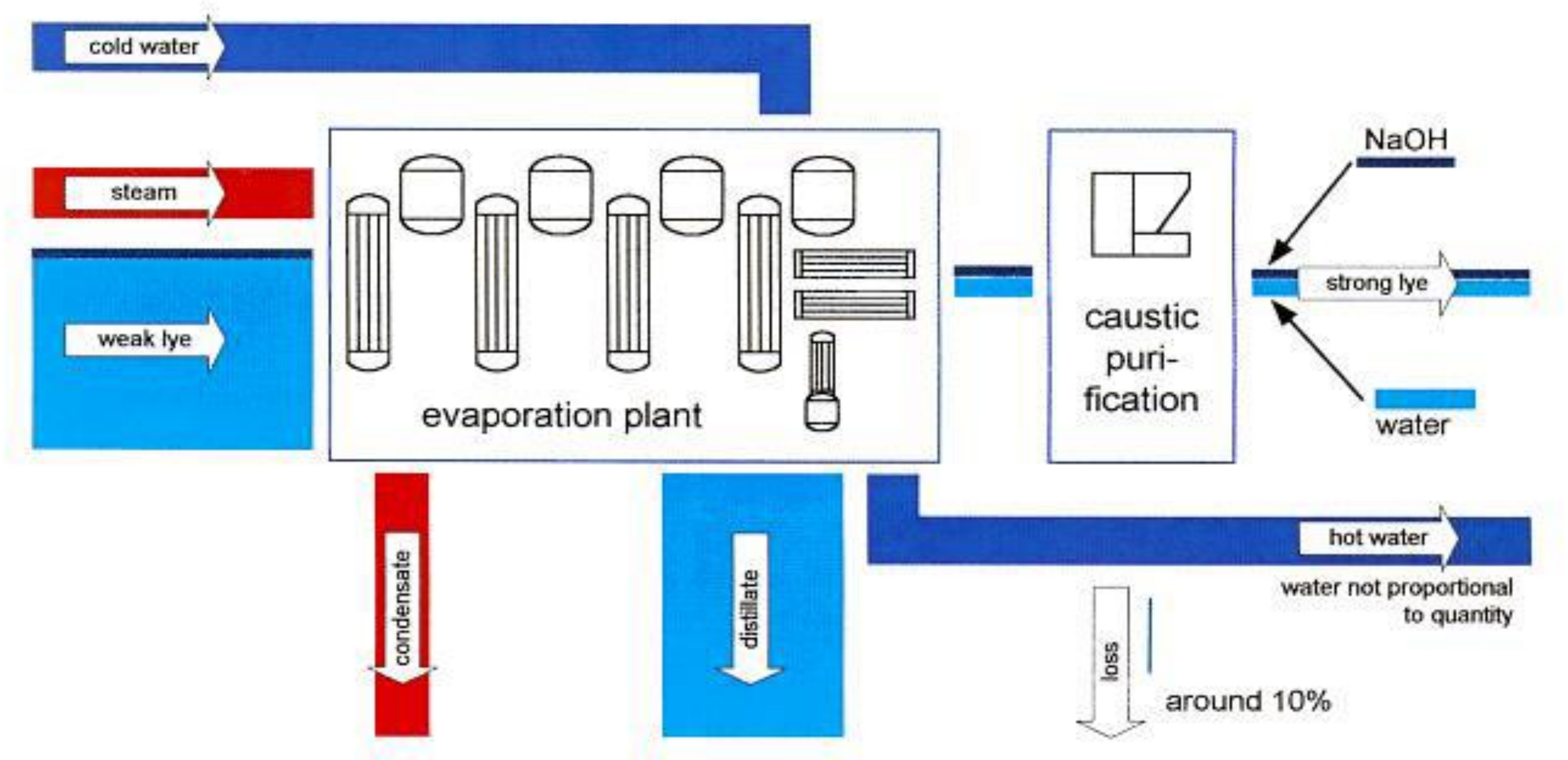
Caustic Recovery

Before evaporation, fibers, and other solid particles are removed by self-cleaning curved screens and microfiltration. In the pre-cleaning stage with curved screens, crystallization of caustic soda occurs via contact of the lye with the carbon dioxide contained in air, resulting in a higher cleaning efficiency compared to rotary filters. More pollution is reduced by the installation of a sedimentation tank.

Weak lye is concentrated in two, three or four steps in the downstream evaporation plant. In the final purification stage, oxidation with hydrogen peroxide destroys the unwanted yellow colour of the strong lye. If the lye is reused after oxidative desizing decolouring can be achieved without any addition of auxiliaries because the bath contains an excess of hydrogen peroxide.

Subsequent cleaning is done by flotation. The recovered lye is cooled before reuse. Subsequently, the cooling water can be used for hot processes. [ÖKOPOL 2011]

Caustic soda recovery process by evaporation followed by lye purification



Caustic soda recovery process by evaporation followed by lye purification

Main Achieved environmental benefits

The alkaline load of the waste water is reduced drastically and the acid required for waste water neutralisation is minimised.
Concentration of the weak lye results in savings of resources (no add-on of new products) and energy (less energy consumption compared to white liquor production).

Environmental performance and operational data
The concentration of weak lye is usually 5-8 °Bè (30-55 g NaOH/l) and is increased may be up to 25-40 °Bè (225-485 g NaOH/l), depending on the mercerising process applied. When mercerisation is carried out on the greige dry textile substrate (raw mercerisation), it is possible to the achievable a concentration of caustic soda is not higher than 25-28 °Bè, whereas a concentration of 40 °Bè can be obtained in non-raw mercerisation. In raw mercerisation, the concentration of impurities is significantly higher, as is the viscosity, which makes it difficult to reach higher concentrations (because the circulation in evaporators is less efficient disturbed).

Caustic soda recovery process by evaporation

For example, a four-step evaporation plant with a capacity of approximately 5 t/h is run by an excess pressure of 2 bar, is charged with lye concentrated at 8 °Bé (approximately 5 % lye) and returns lye at a concentration of 40 °Bé (approximately 35 % lye), for the concentration in the mercerising bath to be 28 °Bé.

For the evaporation, approximately 0.3 kg steam per kg vaporised water are needed corresponding to 1 kg steam/kg recovered NaOH at 28 °Bé or 1.85 kg steam/kg NaOH at 40 °Bé. The higher the number of stages for evaporation, the more often the heat is reused, the lower the steam consumption and, therefore, the running cost. Investment, however, obviously increases with the number of stages.

Mercerising baths are usually recovered and reused. When this is not possible, they are used as alkali in other preparation treatments.

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Economics

Investment costs mainly depend on the plant size and purification technique and typically vary from EUR 200 000 to EUR 800 000 euros. The payback time depends on the plant size and operating time per day. Usually, if mercerisation is practised carried out around 400 hours per year full-time, the payback period is less than 1 year. In companies where non-recovered caustic soda lye has to be neutralised with acid, the payback time is less than 6 months. Thus, from the economic point of view, caustic soda recovery may be very attractive.
In one plant, maintenance costs for curved screens and microfiltration are around EUR 80/week. Investment costs for recovery of 4 000 kg/h of lye are around EUR 330 000 and for 5 700 kg/h around EUR 350 000.

Driving force for implementation
High alkali content of wastewater and economic aspects of caustic soda losses

Recovery of printing paste

There are techniques available that can help to reduce paste residues and techniques for recovery/reuse of the surplus paste. Their efficiency success is, however, limited due to a number of inherent technological deficiencies of analogue printing technology. Most of these deficiencies are related to the analogue transfer of the pattern, the unavoidable contact between the surface of the substrate and the applicator (screen) and the need for thickeners in the formulation (paste rheology), which limits the ultimate potential for paste reuse.

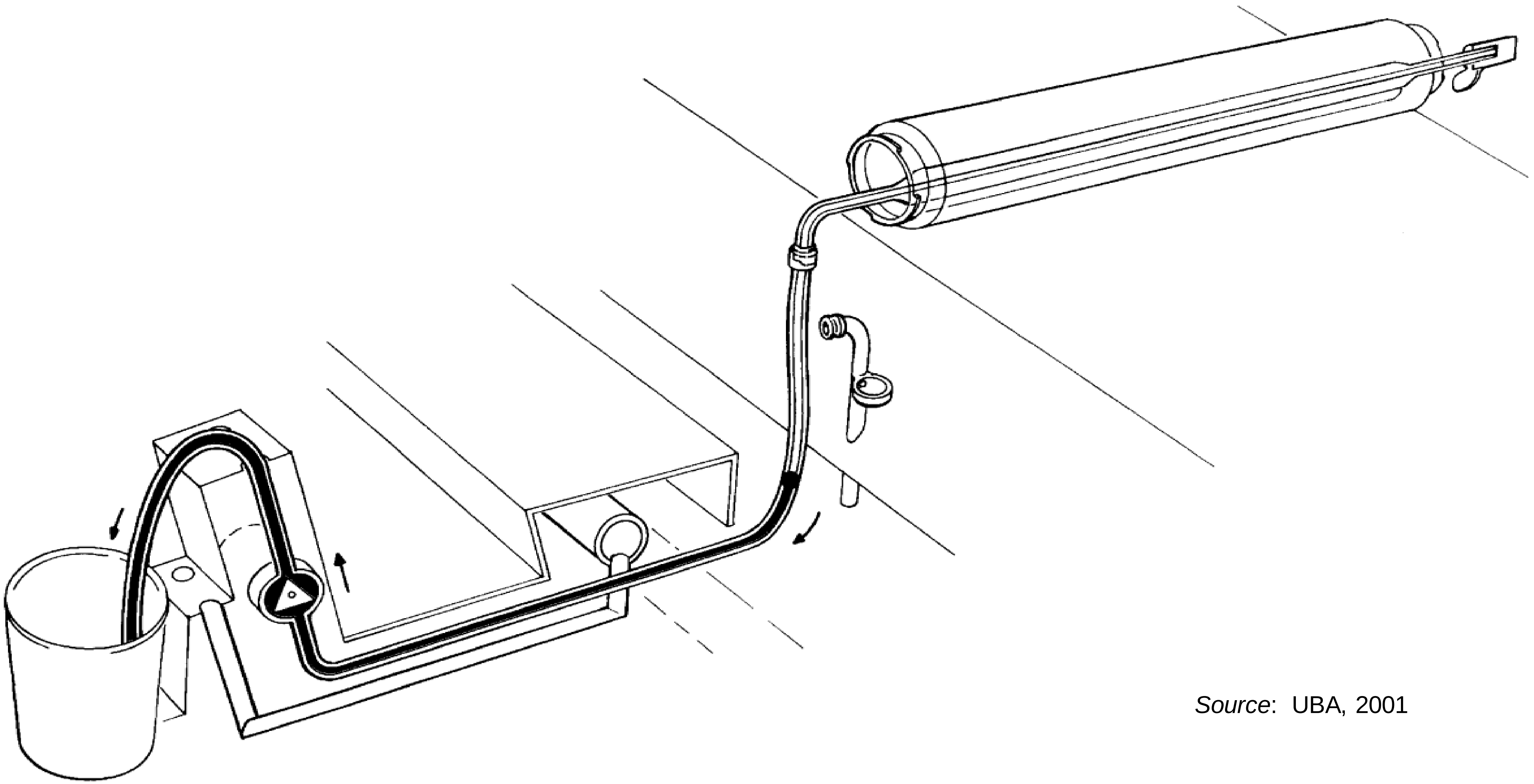
Description

Residual printing paste in the supply system is pumped back or pushed back to its original container (e.g. by a ball controlled by air pressure).

Technical description

This technique allows the recovery of the printing paste remaining in the supply system in rotary screen printing machines at the end of each run. Before filling the system, a ball is inserted in the squeegee and then transported by the incoming paste to its end. After finishing a print run, the ball is pressed back by controlled air pressure, pumping pushing the printing paste in the supply system back into the drum for reuse.

Recovery of printing paste from the paste supply system by back-pumping an inserted ball



Source: UBA, 2001

Recovery of printing paste

Achieved environmental benefits
Reduced generation of waste and of waste water.

Environmental performance and operational data
Printing paste losses are reduced dramatically. In textiles, for instance, at a printing width of 162 cm, the loss is reduced from 4.3 kg (in the case of a non-optimised printing paste supply system) to 0.6 kg.

Rotary screen printing machines have up to 20 supply systems, although in practice, for fashion patterns, 7 - 10 different printing pastes are common. Therefore, the 3.7 kg of printing paste saved per supply system have to be multiplied by 7 - 10. Water pollution can thus be minimised considerably.

To achieve maximum benefit from this measure, modern printing machines with minimum-volume feed systems are should be used

Recovery of printing paste

Technical considerations relevant to applicability
The push-back system is only applicable to rotary screen printing. Certain existing machines can be retrofitted.

The technique is applied in textile finishing mills (for flat fabrics). In principle this system can also work for carpets, but it is not applied for various reasons. Probably The main reason is related to the type of thickeners most commonly used in carpet printing pastes. These are based on guar gum, which is quite relatively inexpensive, but has a limited shelf life and therefore cannot be stored for a long time before reuse (it is biodegradable and the growth of bacteria and other organisms such as yeasts rapidly alters destroy the viscosity).

Economics
The investment for retrofitting this recovery system to a rotary screen printing machine with 12 new squeegees and pipes (for a printing width of 185 cm) is about EUR 42 000. The next table below shows the savings achievable in the reference a typical mill.

Recovery of printing paste

Calculation of savings achievable in a typical textile mill by installing the referenced printing paste recovery system (the number of changes as well as the number of printing pastes per design may be higher in industrial practice)

Number of changes of printpastes per day	**8**
Number of working days per year	250
Average number of printig pastes per design	7
Saving of printing paste saved per supply system	3,7 kg
Price of printing paste	EUR 0,6 / kg
Saving per year	EUR 31.080 / yr
Remark: NB: The number of changes as well as the number of printing pastes per design may be higher in industrial practice. *Source: UBA, 2001*	

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Recovery of printing paste

The example does not include the investment cost of new pumps, so a certain range of viscosity needs to be maintained. When a wide viscosity range is required, the pumps have to be replaced. The total investment cost is then reported to range between about EUR 90 000 and EUR 112 000.

A payback time of about 2 years can therefore be considered realistic, but only when all of the recovered printing paste is reused. In practice this does not happen, especially with mills that use several different types of printing pastes. In such mills, due to logistical problems (limited storage and handling capacities), reuse rates of only 50-75 % are reported, which significantly extends the payback period.

Driving force for implementation

Reduction of printing paste losses for economic and environmental reasons.

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